Active Desiccant Total Energy Recovery Hybrid System Development :

2002 DOE Peer Review: Presented by Kirk Mescher, P.E.

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Project Objectives

- Develop a cost competitive, compact and highly efficient outdoor air preconditioning system capable of completely decoupling the latent load from conventional HVAC packaged systems
- Combine the energy efficiency of a total energy recovery wheel with the “low dewpoint” capability of an active desiccant wheel
- Offer an effective way to accommodate ASHRAE 62 recommendations and effectively utilize waste heat generated by CHP applications

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Brief Description of Program Tasks

- Initial performance modeling to determine best building candidates and CHP potential
- Detailed engineering of government office building to establish overall benefits offered
- Define control strategies
- Optimize active wheel performance
- Design, assemble, instrument and test final prototype system

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Project Team Partnerships

- SEMCO Inc.
  - John Fischer, Program Manager
  - Various others in engineering and R&D
- UIC
  - Doug Kosar, modeling
  - Dr. Bill Worek, wheel matrix optimization
- C&M Engineering
  - Kirk Mescher P.E., design investigation

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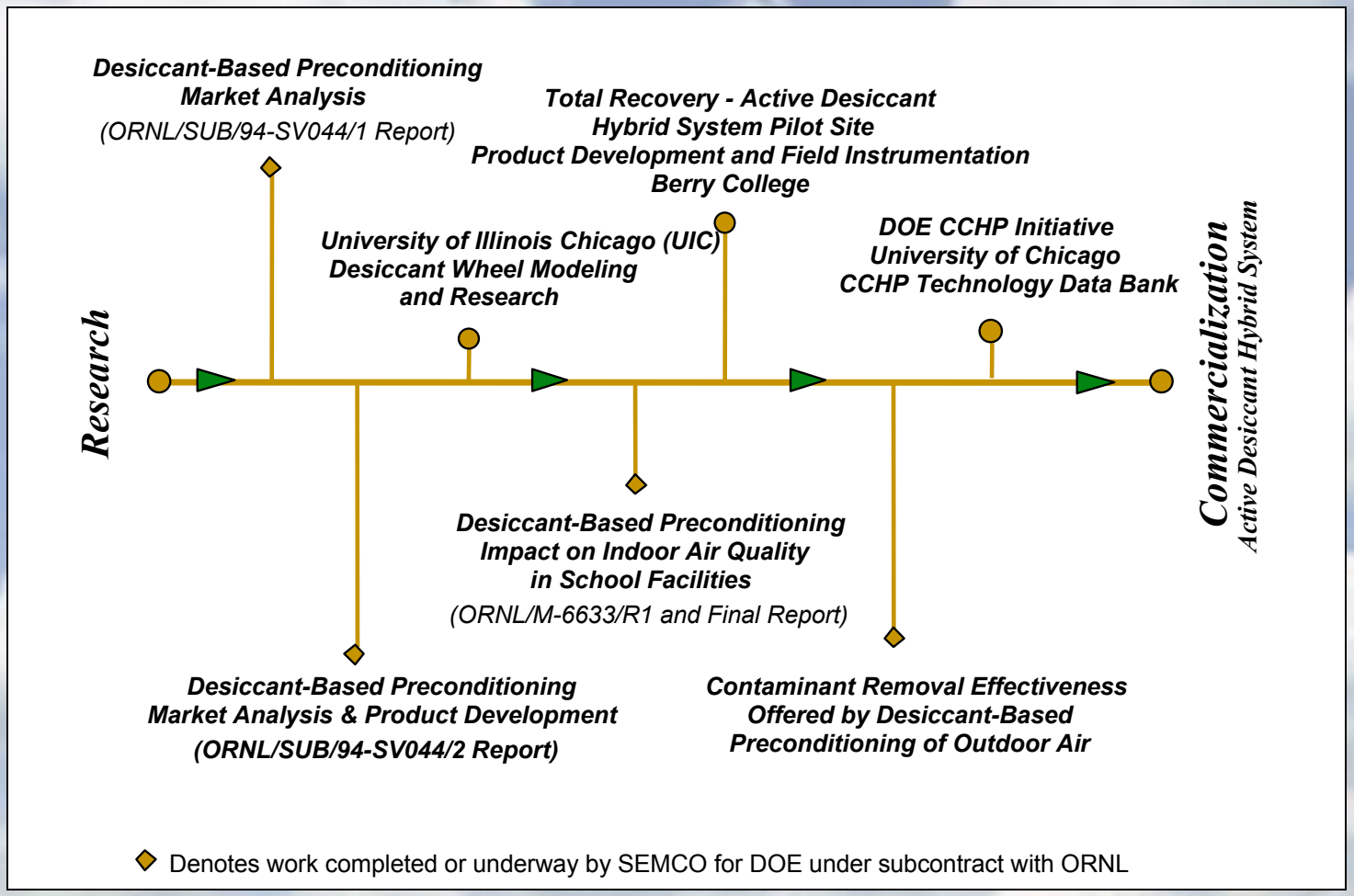
Logical Path to Commercialization



Berry College Mary Hall Dormitory
(hybrid system pilot site and virtual laboratory)

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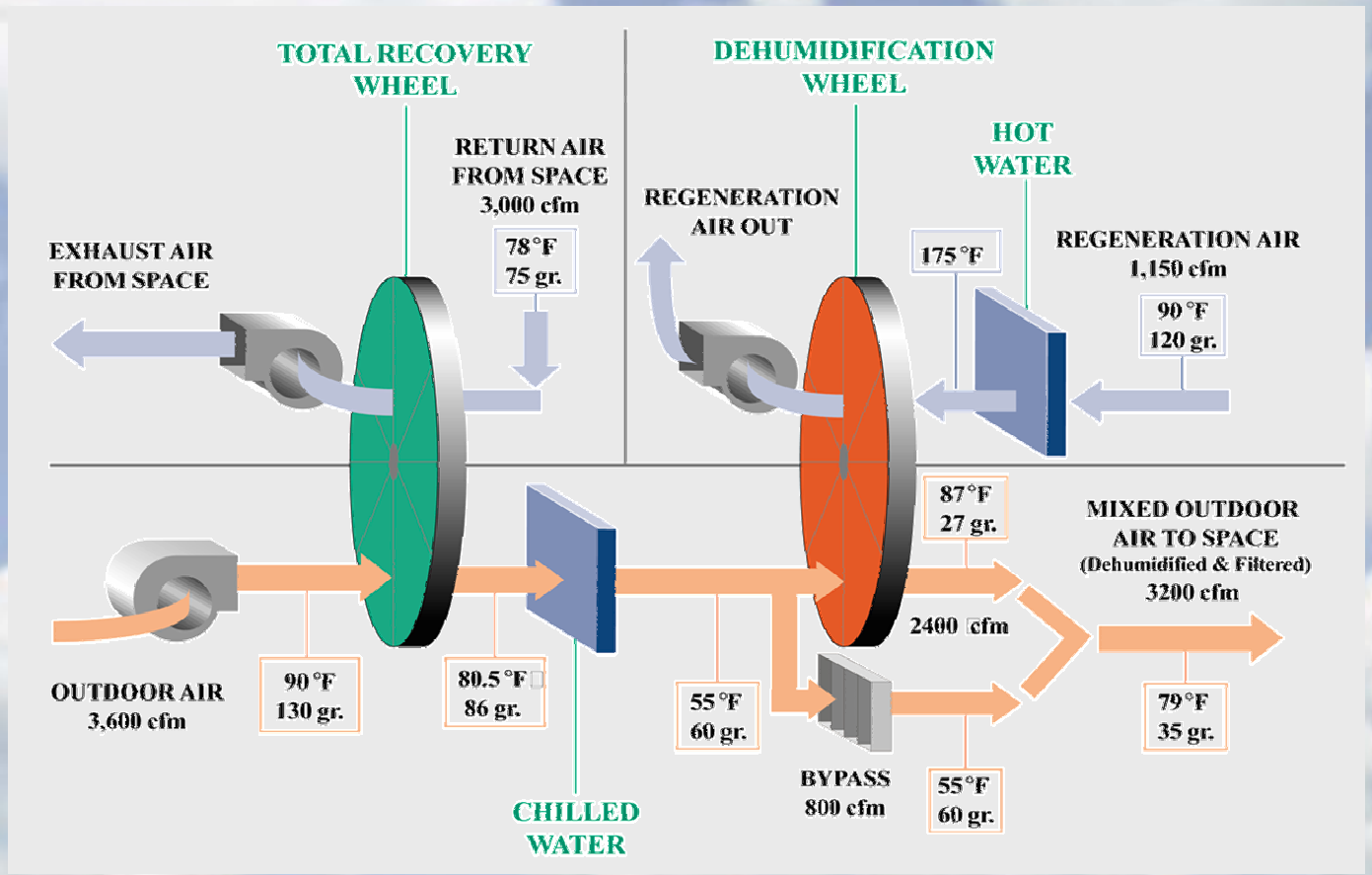
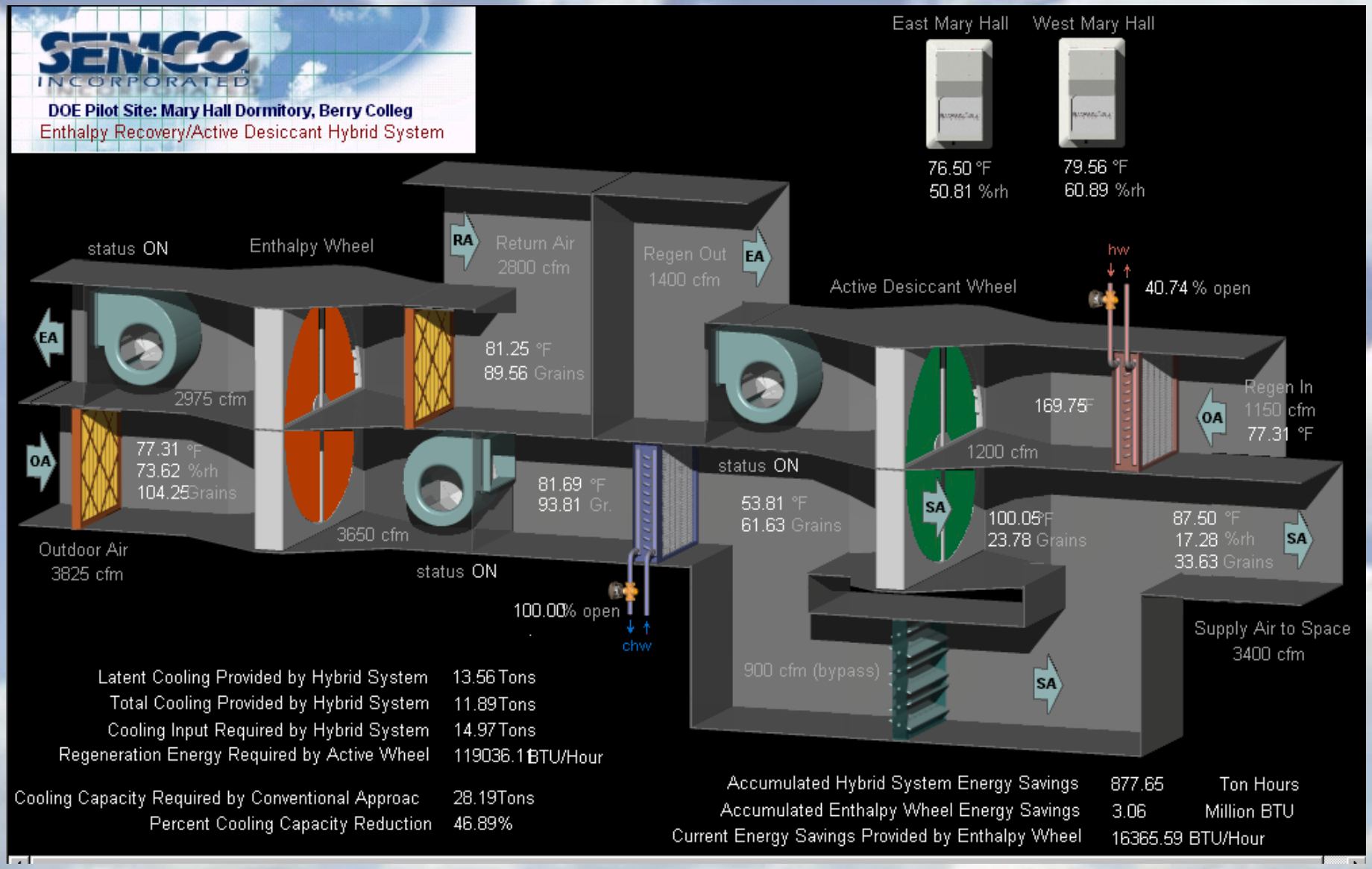
Hybrid System Concept

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DOE Pilot Site: Mary Hall Dormitory, Berry Colleg
Enthalpy Recovery/Active Desiccant Hybrid System
East Mary Hall
West Mary Hall
76.50 °F
50.81 %rh
79.56 °F
60.89 %rh
status ON
Enthalpy Wheel
RA
Return Air
2800 cfm
Regen Out
1400 cfm
EA
Active Desiccant Wheel
hw
40.74 % open
EA
2975 cfm
81.25 °F
89.56 Grains
Regen In
1150 cfm
77.31 °F
OA
169.75°F
OA
77.31 °F
73.62 %rh
104.25Grains
1200 cfm
status ON
81.69 °F
93.81 Gr.
53.81 °F
61.63 Grains
SA
100.05°F
23.78 Grains
87.50 °F
17.28 %rh
33.63 Grains
SA
Outdoor Air
3825 cfm
3650 cfm
status ON
100.00% open
chw
Supply Air to Space
3400 cfm
900 cfm (bypass)
SA
Latent Cooling Provided by Hybrid System 13.56 Tons
Total Cooling Provided by Hybrid System 11.89 Tons
Cooling Input Required by Hybrid System 14.97 Tons
Regeneration Energy Required by Active Wheel 119036.1 BTU/Hour
Cooling Capacity Required by Conventional Approac 28.19 Tons
Percent Cooling Capacity Reduction 46.89%
Accumulated Hybrid System Energy Savings 877.65 Ton Hours
Accumulated Enthalpy Wheel Energy Savings 3.06 Million BTU
Current Energy Savings Provided by Enthalpy Wheel 16365.59 BTU/Hour

Hybrid System Far More Energy Efficient than Conventional Approach

	Cooling Season		Heating Season	Total Annual Energy Consumption	% Conventional Baseline
	Mechanical Cooling	Regeneration Or Reheat Energy	(Heating/Humidification)		
	(BTU/Year)				
Conventional Overcooling/reheat	**4,308 million**	**1,941 million**	**2,037 million**	**8,286 million**	**100%**
Desiccant Based Cooling Approach	**738 million**	**5,740 million**	**309 million**	**6,787 million**	**82%**
Total Recovery Active Desiccant Hybrid	**1,629 million**	**2,104 million**	**151 million**	**3,884 million**	**47%**

Hybrid approach compared with a conventional cooling/reheat and desiccant based cooling (DBC) system.
The analysis is based on conditioning 20,000 cfm of outdoor air, year round in Atlanta.
The analysis assumes that the outdoor air is provided to the occupied space at 75 degrees and 50 grains.

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Hybrid System Design

- Takes advantage of conditioned return air path to provide free dehumidification
- Eliminates the need of evaporative coolers previously utilized by incorporating bypass
- Minimizes the size of the costly active desiccant wheel, maximizes its efficiency by treating saturated air leaving cooling coil

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SEMCO Hybrid System Development:

- Initial Building Analysis Complete
  - Federal office modeled to quantify energy savings, cost impact and comfort
- Many significant benefits identified by analysis
- Excellent preconditioning system for CHP Designs
- Modeling still underway (DOE 2 analyses)
- Next step product definition – wheel optimization
  - Teamed with experience of UIC research
- Full scale prototype to be built and laboratory tested as part of phase 1

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Office Building Jefferson City Mo.
(used for baseline engineering evaluation)

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Engineering Analysis: Government Office Building

PACKAGED ROOFTOP UNIT SCHEDULE										
APPROACH	SIZE	FAN		COOLING COIL		BURNER	ELECTRICAL			MIN O. A.
		CFM	HP	TOTAL MBTUH	SENSIBLE MBTUH	INPUT MBTUH	V	PH	MCA	
Base RTU	105 Tons	32,550	50	1222	938	945	460	3	283	4000
BASE W/ERU RTU	90 Tons	31000	50	1051	876	938	460	3	262	4000
DESICCANT HYBRID	60 Tons	27000	40	749	727	650	460	3	165	4000
REDUCTION FROM BASE	43%	17%	20%	39%	22%	31%			42%	

Results of comparison made between conventional packaged system, Packaged system with total energy recovery and active desiccant/total Recovery hybrid system

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Hybrid Benefits Identified

- Significant energy savings, improved humidity control - higher thermostat settings
- First cost savings from smaller packaged units
- Electrical first cost savings associated with smaller service, lower peak KW
- Improved part load performance and building pressurization
- Heating season humidificaiton

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Hybrid System Can Be Cost Effective

PACKAGED ROOFTOP UNIT SCHEDULE					
APPROACH	PACKAGE UNIT SIZE	PACKAGE UNIT COST	ER OR HYBRID COST	COMBINED COST	SIMPLE PAYBACK
Base RTU	105 Tons	$78,900	N/A	$78,900	N/A
BASE W/ERU RTU	90 Tons	$72,400	$11,000	$83,400	1.5 YEARS
DESICCANT HYBRID	60 Tons	$46,500	$37,400 (3)	$83,900 (2)	1 YEAR (1)
REDUCTION FROM BASE	43%	41%			

Note 1: Assumes payback fixed at one year to compute projected sales price
Note 2: Combined sales price based on one year payback using estimated annual savings of $5,500/year
Note 1: Potential selling price of active desiccant - total energy recovery hybrid system based on assumptions

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Cosorption of Contaminants by Composite Desiccant Wheel

- Effective contaminant removal has been documented for composite desiccant active wheel through testing at GTRI and Berry sites
- Opens the door for those who wish to pursue a “prescriptive” approach to IAQ
- Effective solution to facilities located in urban environments and laboratory facilities

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Cosorption Test Results: Berry College "Cleaning" Effect of Composite Desiccant Active Wheel

Contaminant	Outdoor Air Concentration (ug/m3)	Supply Air Concentration (ug/m3)	Removal Efficiency
2-(2-butoxyethoxy)ethanol	66.9	9.9	**85%**
2-butoxyethanol	34.3	8.2	**76%**
ethosuximide	47.6	0.8	**98%**
hexadecane	26.6	5.7	**79%**
isopropylalcohol	29.8	0.8	**97%**
limonene	53.8	3.0	**94%**
Total VOC Concentration (considering all contaminants)	899	179	**80%**

Percent Removal of Outdoor Air Contaminants (contaminants with the highest concentration)
Results of DOE funded research program, completed by the Georgia Tech Research Institute

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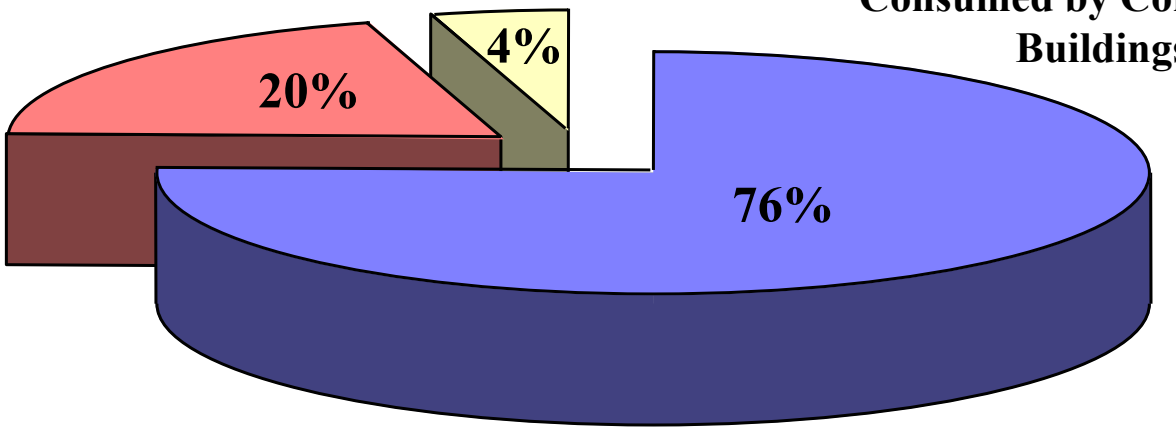
Energy Impact: Ventilation Air

Projected Energy Reduction Possible with Active and/or Passive Desiccant Systems by Preconditioning Outdoor Air to Commercial Buildings



U.S. Commercial Buildings Energy Consumption Increase Over 10 Years:

DOE Projected Base Energy Increase: Years 1990 to 2000 (1.31 Quadrillion BTU)

SEMCO Phase 1 Report: ORNL/SUB/94-SV044/1

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